Cruise Report
GHOSTS 2002 (Gulf Hydrate Observation, Sampling, and Tracer Study)
6-14 June 2002

Overview

This report describes the objectives, techniques, and accomplishments of a research cruise that used the submersible JOHNSON SEA LINK (JSL) and its support ship RV SEWARD JOHNSON II (SJII) to observe, collect and perform tracer experiments on a natural deposit of methane hydrate. The project's official title is "Controls on Gas Hydrate Formation and Dissociation, Gulf of Mexico: *In situ* field study with laboratory characterizations of exposed and buried gas hydrate." For convenience, this title has been shorted to the acronym Gulf Hydrate Observation, Sampling, and Tracer Study (GHOSTS). The principal investigators for the project and co-chief scientists for the cruise are Miriam Kastner (Scripps Institute of Oceanography) and Ian MacDonald (Texas A&M University). This cruise is the first of two cruises, with the second cruise to be completed in June-July of 2003. The general objectives of the GHOSTS 2002 cruise were to deploy several osmotic membrane samplers plus flow meters (MOSQUITOs: Multiple Orifice Sampler and Quantitative Injection Tracer Observer) that can collect a rigorous time series of pore fluids from sediments and monitor the associated flow rate. Environmental control on these experiments requires use of a time-lapse camera and high resolution thermistors. Controls on the chemical composition of gas hydrate and its impact on the sediment and water column were obtained by extensive collections of sediment cores and water samples. A specially designed hydrate drill with large-diameter auger was used to collect intact sample of gas hydrates. The MOSQUITO was re-designed for this cruise, and newly designed Tee-Bars for sampling continuously *in situ* large-volume fluid samples, were as well deployed.

Integration with ancillary programs

The GHOSTS has been integrated with related research programs that are studying gas hydrates and hydrocarbon seeps in the Gulf of Mexico. This integration gives the investigators access to expertise and results from other programs. It also makes it possible to conduct limited sampling and observations on other cruises that are scheduled for 2002. The following programs are in direct cooperation with the GHOSTS program: "Microbiology of gas hydrate and brine pools in the Gulf of Mexico," funded by NSF-Life in Extreme Environments program. Ian MacDonald is a PI on this program, which has a 3 week cruise with SJII and JSL scheduled for July 2002. MacDonald will be able to check the status of GHOSTS instruments, deploy additional instruments, and collect more gas hydrate cores during this cruise. The National Undersea Research Program and the Ocean Exploration Initiative of NOAA have sponsored additional dives during July. These dives will be used to explore the GHOSTS site with sidescan sonar and hopefully discover additional gas vents.

Cruise Accomplishments

Dive table

Dive Number	Date	Location	Depth (m)	Sphere obs. Chamber obs.	Activities
Port	6 June	Gulfport	NA		Load ship, cruise preparations
Transit	7 June	NA	NA	NA	Sample prepartions
4416	8 June, 8 AM	Bush Hill	540	I. MacDonald M. Kastner	Recovered thermistor probes. Niskin bottle. Collected video for photomosaic. Took 2 push cores (1 CH4, 1 reg). Collected hydrate sample.
4417	8 June, 3 PM	Bush Hill	540	M. Kastner E. Solomon	Deployed Mosquito #1. Recovered time-lapse camera. Took 4 push cores (2 CH4, 2 reg)
4418	9 June, 8 AM	Bush Hill	540	M. Kastner Y. Weinstein	Deployed Mosquito #2. Took 3 push cores (1CH4, 1 reg, 1 electrd)
4419	9 June, 3 PM	Bush Hill	540	I. MacDonald M. Vardaro	Collected hydrate sample with large and small augers. Niskin bottle. Deployed thermistor probes (2X2). 5 push cores (2 CH4, 2 reg, 1 electrd). Gas sample. Bubble visualization. Water samples with intake ~2 m from bubble plume
4420	10 June, 8 AM	Bush Hill	540	G. Robertson PIT	Deployed Tee-bar #1 & 2. Niskin bottle. 4 push cores
4421	10 June, 3 PM	Bush Hill	540	M. Vardaro W. Wei	Deployed TL camera. Deployed Tee-bar #3. Moved thermistor probe near gas vent. 5 push cores (2 CH4, 2 reg, 1 electrd). Coolpix photos. Gas sample from southern vent. Water samples with intake in bubble stream. Niskin bottle.
Weather	11 June, 8 AM				
Weather	11 June, 3 PM				
4422	12 June, 8 AM	Bush Hill	540	E. Solomon L. Bender	Deployed Mosquito #3. Deployed Tee-bar #4. Moved Tee-bar 3 to hole on top of hydrate mound
4423	12 June, 3 PM	Bush Hill	540	Y. Weinstein A. Aubrey	Deployed Mosquito #4. Coolpix photos. 4 push cores (2 CH4, 2 reg). Deployed Tee-bar #5
Transit	13 June	NA	NA	NA	Sample storage, data QA/QC, packing
Port	14 June	NA	NA	NA	Sample shipment, unload ship, return home

Participants and contact information

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TAMU: Geochemical and Environmental Group, Texas A&M Univ.
Scripps: Scripps Inst. of Oceanography, Univ. of California San Diego
UNAM: Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México
UGA: Univ. of Georgia Athens

Sampling overview

An overview of day activities with the JOHNSON SEA LINK during the cruise is given in Table 1. Night activity consisted of hydrocast deployments, CTD mapping of the Bush Hill site and water column sampling for dissolved solutes and gas analyses. Cruise participants are listed in Table 2. A detailed map of the sampling area and hydrate mound at the Bush Hill site is shown in Figure 1. A large hydrate deposit probably underlies the entire area depicted in the map. Active gas seeps and abundant chemosynthetic fauna are common at the site.

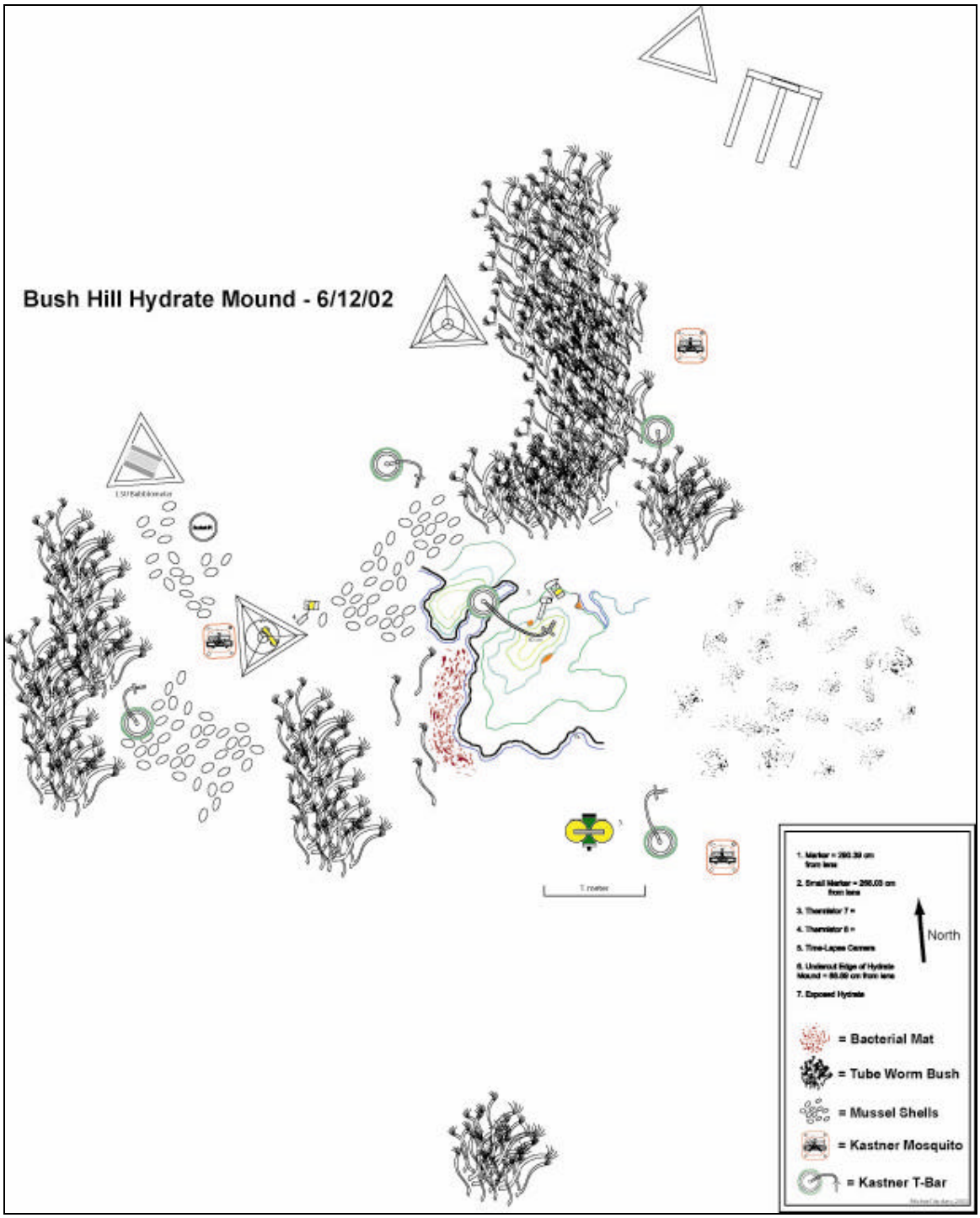


Figure 1 Site map of Bush Hill hydrate mound as of 6/12/02. The mosquito and tee-bar in the upper left (arrow) are also show in Fig 2.

[Miriam, describe deployment of mosquitos and teebars]

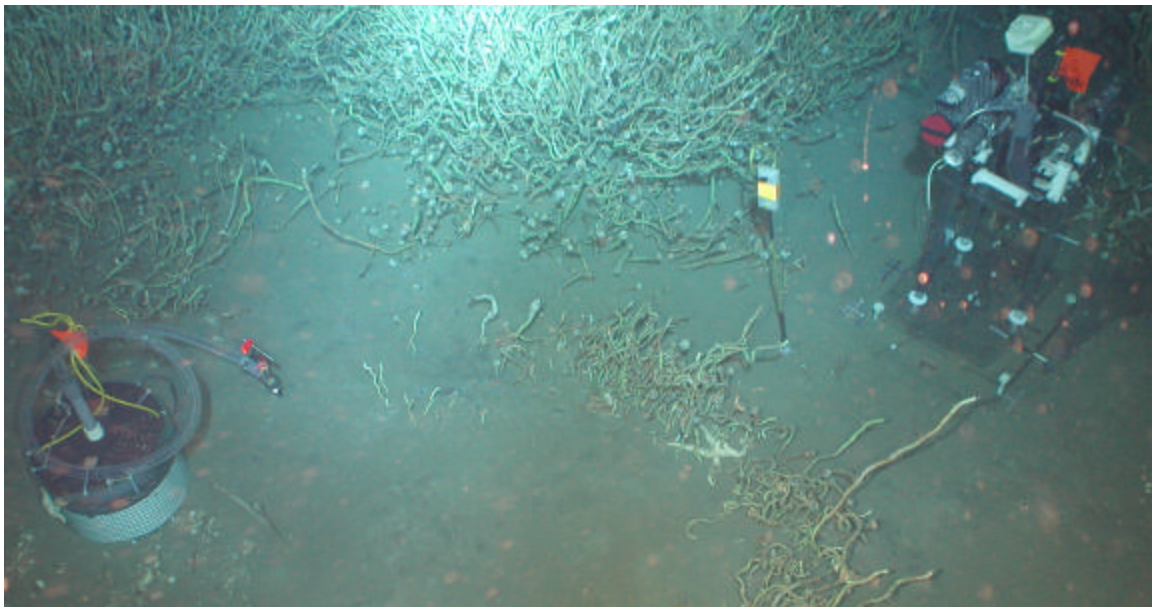


Figure 2 Tee-bar (left) and mosquito (right) deployed near hydrate mound. See map in Fig. 5 for location.

Thermistor probes 1 and 2 were recovered during dive #4416, and temperature data from Antares data loggers #33, 34, 41 and 42 was removed and downloaded. 15,693 data points were collected over the period from deployment on 7/16/01 to recovery on 6/8/02, with a sampling frequency of 30 minutes. Probe 1 had been placed in hydrate, with thermistor #33 buried 7 cm into a hydrate drill hole and thermistor #34 exposed to the water (**Fig. 3**). Probe 2 was positioned so that thermistor #42 was buried in 49 cm of sediment and thermistor #41 was exposed to the water (**Fig. 4**).

A time-lapse camera, which was deployed on 7/17/01, was also recovered on 6/8/02, during dive #4417. Three months of images—a total of 379 images were downloaded from the digital CoolPix camera, as the battery lasted until 10/19/02. Images were recorded every 6 hours, and record changes (and similarities) in the state of the hydrate mound and animal population of the area over the deployment period (**Fig. 5**).

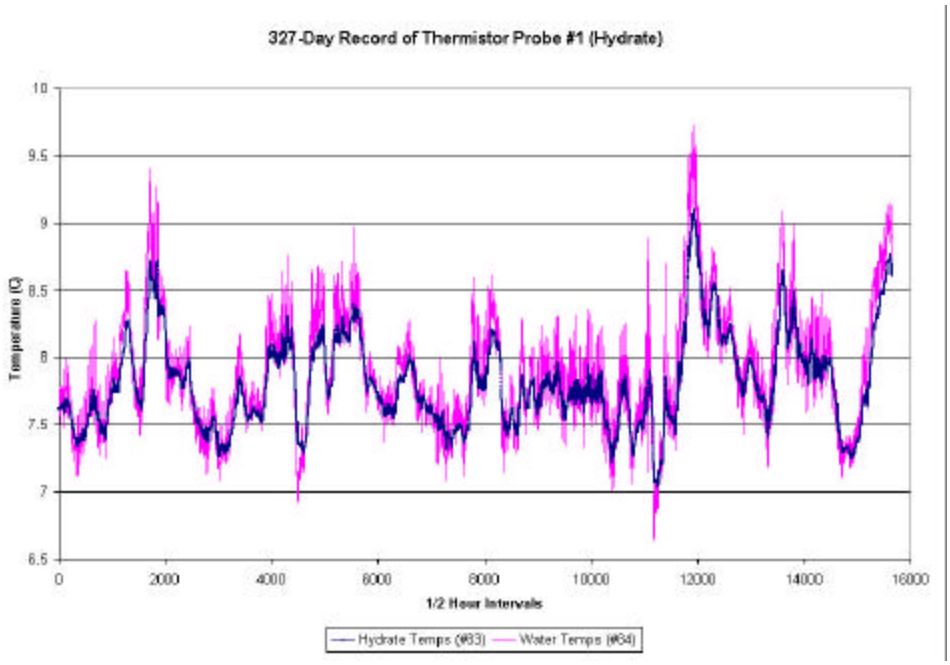


Figure 3. Plot of thermistor data from probe 1, which was deployed in a ~6-cm deep hole in a hydrate deposit. The high-amplitude record shows bottom water temperatures.

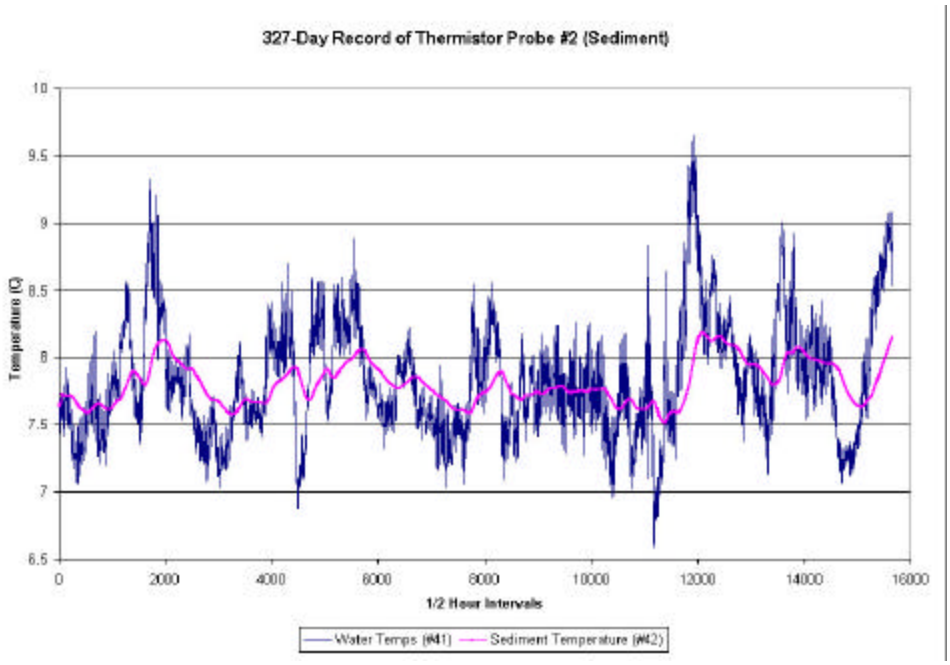


Figure 4 Plot of thermistor data from probe 1, which was deployed implanted ~50 cm deep in sediment next to a hydrate deposit. The high-amplitude record shows bottom water temperatures.

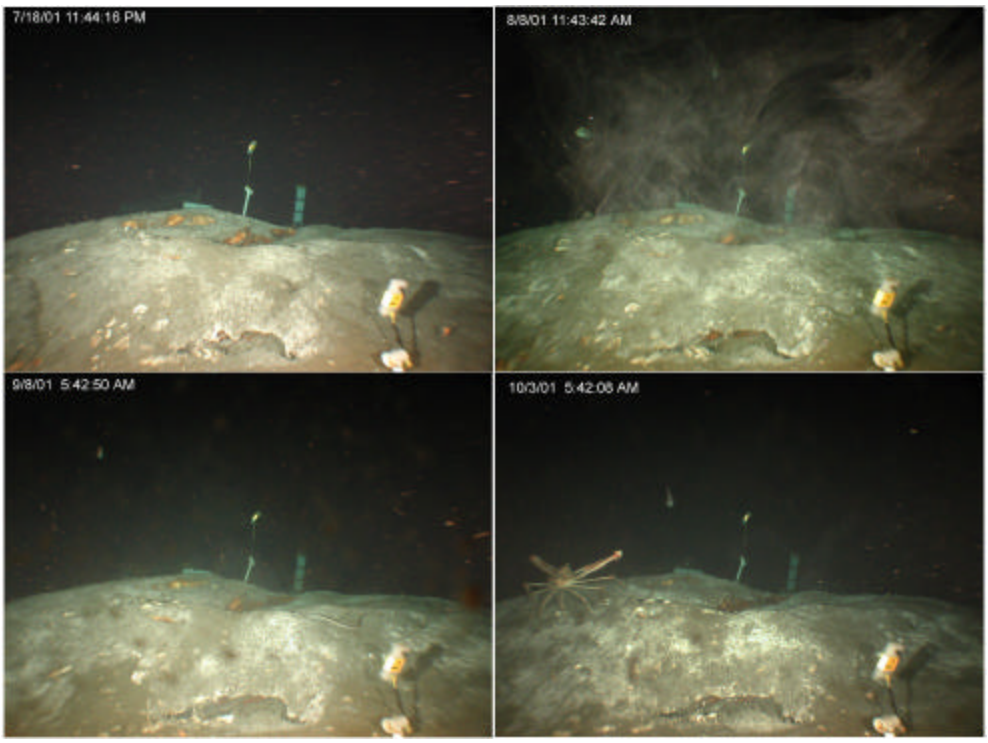


Figure 5 Time-lapse photos of the Bush Hill hydrate mound. Thermistor probe #1 is visible in the center of the frame. Pictures number 10, 92, 215 and 315 from days 2, 23, 53, and 78 of the deployment.

Dates and location

The RV SEWARD JOHNSON II was chartered to the project during 6-14 June, 2002. The cruise comprised two mobilization/demobilization days in Gulfport, MS, two days transiting to and from the operations area, and five operational days. All operations were conducted at the Bush Hill natural hydrocarbon seep in lease block GC185. Approximate location of this site is 27°47.0'N and 91°30.5'W at a water depth of 540 m.

Problems encountered and solutions

The most serious problem encountered was the loss of one entire operations day (11 June) due to rough weather. Because of the reduced schedule, the second sampling site could not be visited. This meant that except for two hydrocasts all samples were collected at Bush Hill. Comparative samples can be collected during the second year of the project. Deployment of the MOSQUITOS required extensive manipulations on the seafloor, but acceptable deployments were accomplished for all samplers. The large bore hydrate drill did not break off the core on the first attempt. Following adjustments to the JSL hydraulic system, a six-inch core was successfully recovered on the second attempt. The weather day and the time required for MOSQUITO deployments prevented a third attempt. Water column sampling by use of a Niskin bottle rosette was limited because the ship operator provided a 12-bottle rosette instead of the 24-bottle rosette that had been requested. This doubled the time required for high-resolution water sampling two

lowerings per site) for chemical profiles, but ultimately all planned samples were collected.

Description of sampling & analysis techniques

In-situ sampling devices: MOSQUITOs and Tee-Bars

Four MOSQUITOS and five T- Bars were successfully deployed at Bush Hill during this cruise. A T-Bars was deployed adjacent to each MOSQUITO; the T-Bars were particularly designed for acquiring a time series of large gas samples. This is especially important in a gas-rich region like Bush Hill. The MOSQUITOS were designed to provide a time series of solute concentrations and fluid flow rates. Three of each were deployed adjacent to the Bush Hill hydrate mound; one pair in a mussel field, the second in a bacterial mat field, and a third in a tube-worm field. The 4th pair of a MOSQUITO plus T-Bar was deployed a few tenths of meters SW of the hydrate mound, to record the "background" chemistry and fluid flux. The 5th T-Bar was deployed on the hydrate mound in the space vacated by the hydrate drill core.

Hydrocasts and CTDs

Nine high resolution water–column-profile samples were acquired from the Bush Hill region, including from gas-plume and "background" sites, for comprehensive solute and dissolved gas analyses, including CFCs. Special emphasis was given to sampling (1) bottom water, and (2) the deeper section of the water column to document the chemical effects of gas venting on seawater chemistry, as well as to sampling (3) the shallower section of the water column to document if and how much methane is presently reaching the atmosphere at Bush Hill.

Satellite observations

A RADARSAT synthetic aperture image was collected on 10 June. This scene covers the Bush Hill area sampling site. Although the weather was rough on this date natural oil slicks are clearly visible over the seep location.

ADCP mooring and transects

An ADCP mooring (see Fig. 5) was successfully deployed on June 8, 2002 in 570 m (1870 ft) of water approximately 1.5 nautical miles to the north east of Bush Hill. One 300 kHz Workhorse ADCP is presently sampling the upper 80-100 m of the water column using 40 2-m bins and a second 300 kHz Workhorse ADCP is sampling the bottom 80-100 m using the same configuration. The mooring is scheduled to be recovered on July 10, 2002 utilizing a research vessel of opportunity. This will provide nearly five weeks of currents recorded every minute. This data set will be highly useful in correlating the appearance of slicks with the prevailing current regime.

In addition to the deployment of the mooring, an extensive ADCP survey using the R/V Seward Johnson II 75 kHz Ocean Surveyor was conducted on June 10 and 11. The instrument was configured to sample 8-m bins to a total water depth of 700 m, more than enough for the expected depths in the vicinity of Bush Hill. A square transect, aligned along north-south and east-west lines, with sides 3 nautical miles long, and the north east

corner of the square sited over the ADCP mooring, was surveyed at least five complete times. In addition, during one of the transects CTD casts were made at each of the four corners. During the two immediate follow-on cruises undertaken by the R/V Johnson (17-26 June and 5-20 July) the ship's crew and marine technicians will attempt to collect additional ADCP data during slack periods

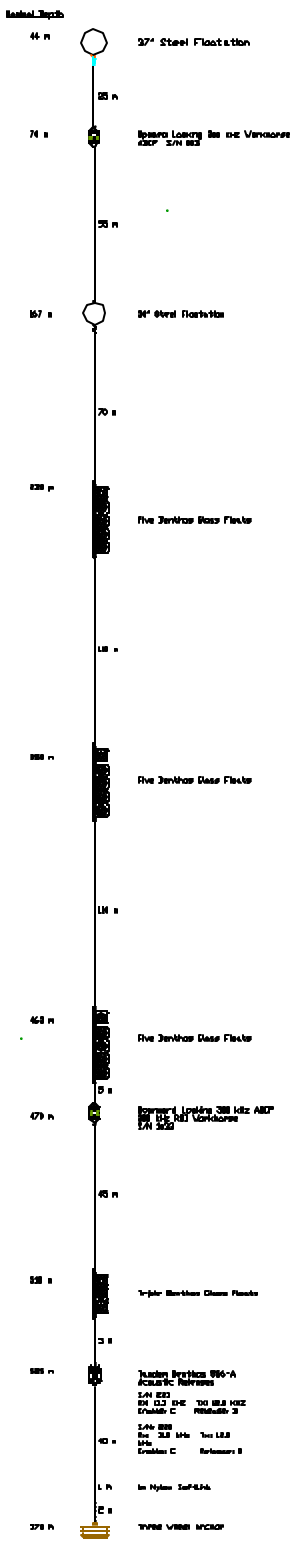


Figure 6 Diagram of ADCP mooring.

Anticipated results

Reports

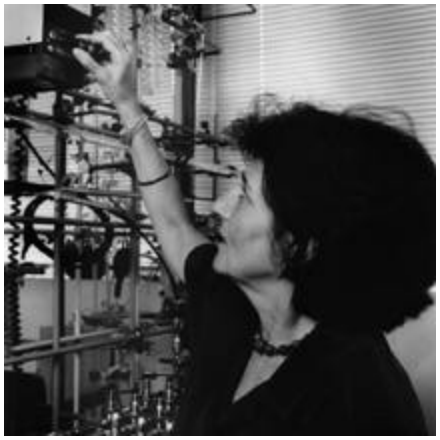
Results from the cruise will be presented to DOE-NETL when the principal Investigators visit the Morgan Town national laboratory. Written progress reports will be submitted per requirements of the award.

Publications

Papers for publication in peer-reviewed journals will be prepared and submitted during 2002 and 2003. Possible journals include Journal of Geophysical Research, Earth and Planetary Research Letters, Geology, and Science or Nature.

Principal Investigators

Miriam Kastner



Miriam Kastner, professor of geology with the Geosciences Research Division of Scripps Oceanographic Institution is Principal investigator for the GHOST program. Kastner takes a process-oriented approach to oceanography and to reaching personal goals.

Kastner teaches several classes, goes to sea, and conducts a variety of laboratory research. She investigates such diverse subjects as the geochemical history of seawater, submarine mineralization processes, the mineralogy and geochemistry of marine sediments, and the nature, origin, and fluxes of fluids in subduction zones.

For a geologist-geochemist focusing on the processes that influence seawater chemistry and change the nature of marine sediments and rocks over time, oceanography is a wonderful environment to work in. Working in the modern oceanic environment enables her to study ongoing processes and their rates, and to gain insights into oceanographic feedback mechanisms.

Ian MacDonald

Ian R. MacDonald, a Research Scientist with the Geochemcial and Environmental Research Group of Texas A&M University. MacDonald is an expert on the biology and geology of marine oil seeps, having published some 30 peer-reviewed articles and over 50 reports and popular articles on the subject--including articles in National Geographic and Scientific American. His research has entailed extensive use of such deep-diving submarines as Johnson Sea-Link, Alvin, and the Navy nuclear submarine NR-1. Altogether he has spent an estimated 50 continuous days at depths of 2000 feet or more in the Gulf of Mexico. His particular interest is the application of advanced imaging technology to marine research; this includes satellite detection of oil slicks, as well as application of satellite image processing techniques to analyze images collected from submarines. Although primarily focused on his home region of the Gulf of Mexico, he maintains an active international perspective.